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Forbes, Jr.

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(54) **SYSTEMS AND METHODS FOR DETERMINING AND UTILIZING CUSTOMER ENERGY PROFILES FOR LOAD CONTROL FOR INDIVIDUAL STRUCTURES, DEVICES, AND AGGREGATION OF SAME**

(58) **Field of Classification Search**
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(56) **References Cited**

U.S. PATENT DOCUMENTS

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3,906,242 A 9/1975 Stevenson
4,023,043 A 5/1977 Stevenson
(Continued)

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FOREIGN PATENT DOCUMENTS

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EP 1729223 A 12/2006
JP 2000078748 A 3/2000
(Continued)

This patent is subject to a terminal disclaimer.

OTHER PUBLICATIONS

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(63) Continuation of application No. 13/464,665, filed on May 4, 2012, now Pat. No. 9,177,323, which is a (Continued)

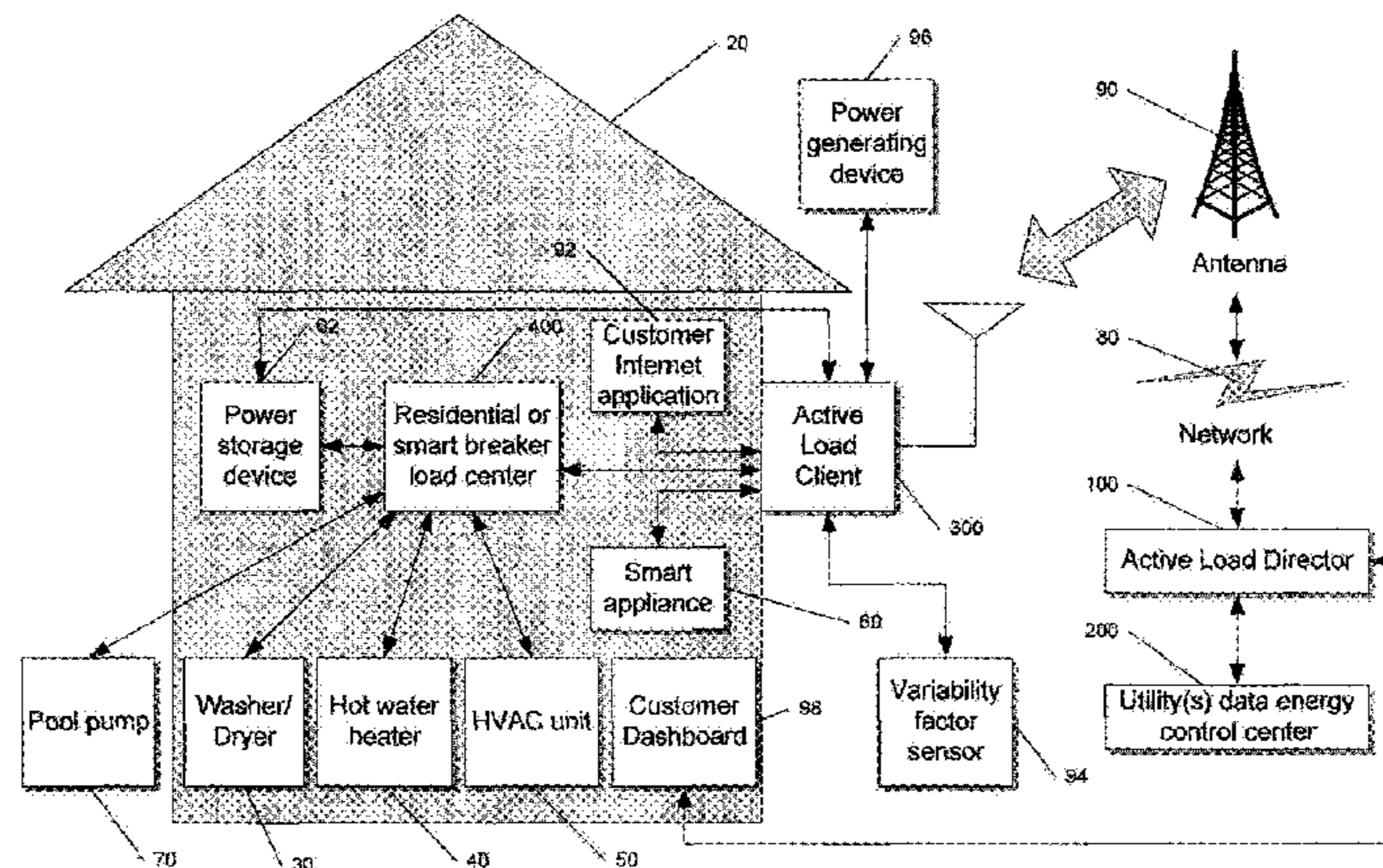
(57) **ABSTRACT**

A system and method for creating and making use of customer profiles, including energy consumption patterns. Devices within a service point, using the active load director, may be subject to control events, often based on customer preferences. These control events cause the service point to use less power. Data associated with these control events, as well as related environment data, are used to create an energy consumption profile for each service point. This can be used by the utility to determine which service points are the best targets for energy consumption. In addition, an intelligent load rotation algorithm determines how to prevent the same service points from being picked first each time the utility wants to conserve power.

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continuation-in-part of application No. 13/019,867, filed on Feb. 2, 2011, now Pat. No. 8,996,183, which is a continuation-in-part of application No. 12/702,640, filed on Feb. 9, 2010, now Pat. No. 8,131,403, which is a continuation-in-part of application No. 11/895,909, filed on Aug. 28, 2007, now Pat. No. 7,715,951, said application No. 13/464,665 is a continuation-in-part of application No. 12/896,307, filed on Oct. 1, 2010, now Pat. No. 8,527,107, which is a continuation-in-part of application No. 12/702,640, filed on Feb. 9, 2010, now Pat. No. 8,131,403, which is a continuation-in-part of application No. 11/895,909, filed on Aug. 28, 2007, now Pat. No. 7,715,951.

(51) **Int. Cl.**

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(52) **U.S. Cl.**

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See application file for complete search history.

(56)

References Cited

U.S. PATENT DOCUMENTS

4,589,075 A 5/1986 Buennagel
 4,799,059 A 1/1989 Grindahl et al.
 4,819,180 A 4/1989 Hedman et al.
 4,819,229 A 4/1989 Pritty et al.
 5,237,507 A 8/1993 Chasek
 5,361,982 A 11/1994 Liebl et al.
 5,388,101 A 2/1995 Dinkins
 5,462,225 A 10/1995 Massara et al.
 5,481,546 A 1/1996 Dinkins
 5,502,339 A 3/1996 Hartig
 5,544,036 A 8/1996 Brown, Jr. et al.
 5,570,002 A 10/1996 Castleman
 5,592,491 A 1/1997 Dinkins
 5,640,153 A 6/1997 Hildebrand et al.
 5,644,173 A 7/1997 Elliason et al.
 5,675,503 A 10/1997 Moe et al.
 5,696,695 A 12/1997 Ehlers et al.
 5,721,936 A 2/1998 Kikinis et al.
 5,926,776 A 7/1999 Glorioso et al.
 5,973,481 A 10/1999 Thompson et al.
 6,018,690 A 1/2000 Saito et al.
 6,037,758 A 3/2000 Perez
 6,078,785 A 6/2000 Bush
 6,102,487 A 8/2000 Oevreboe
 6,107,693 A 8/2000 Mongia et al.
 6,115,676 A 9/2000 Rector et al.
 6,154,859 A 11/2000 Norizuki et al.
 6,216,956 B1 4/2001 Ehlers et al.
 6,233,327 B1 5/2001 Petite
 6,254,009 B1 7/2001 Proffitt et al.
 6,304,552 B1 10/2001 Chapman et al.
 6,366,217 B1 4/2002 Cunningham et al.
 6,374,101 B1 4/2002 Gelbien
 6,437,692 B1 8/2002 Petite et al.
 6,519,509 B1 2/2003 Nierlich et al.
 6,535,797 B1 3/2003 Bowles et al.
 6,577,962 B1 6/2003 Afshari

6,583,521 B1 6/2003 Lagod et al.
 6,601,033 B1 7/2003 Sowinski
 6,602,627 B2 8/2003 Liu et al.
 6,621,179 B1 9/2003 Howard
 6,622,097 B2 9/2003 Hunter
 6,622,925 B2 9/2003 Carner et al.
 6,633,823 B2 10/2003 Bartone et al.
 6,671,586 B2 12/2003 Davis et al.
 6,681,154 B2 1/2004 Nierlich et al.
 6,687,574 B2 2/2004 Pietrowicz et al.
 6,718,761 B2 4/2004 Merswolke et al.
 6,732,055 B2 5/2004 Bagepalli et al.
 6,747,368 B2 6/2004 Jarrett
 6,778,882 B2 8/2004 Spool et al.
 6,784,807 B2 8/2004 Petite et al.
 6,832,135 B2 12/2004 Ying
 6,834,811 B1 12/2004 Huberman et al.
 6,836,737 B2 12/2004 Petite et al.
 6,862,498 B2 3/2005 Davis et al.
 6,865,450 B2 3/2005 Masticola et al.
 6,868,293 B1 3/2005 Schurr et al.
 6,879,059 B2 4/2005 Sleva
 6,891,838 B1 5/2005 Petite et al.
 6,904,336 B2 6/2005 Raines et al.
 6,906,617 B1 6/2005 Van Der
 6,909,942 B2 6/2005 Andarawis et al.
 6,914,533 B2 7/2005 Petite
 6,914,893 B2 7/2005 Petite
 6,934,316 B2 8/2005 Cornwall et al.
 6,961,641 B1 11/2005 Forth et al.
 6,990,593 B2 1/2006 Nakagawa
 7,003,640 B2 2/2006 Mayo et al.
 7,019,667 B2 3/2006 Petite et al.
 7,035,719 B2 4/2006 Howard et al.
 7,039,532 B2 5/2006 Hunter
 7,053,767 B2 5/2006 Petite et al.
 7,088,014 B2 8/2006 Nierlich et al.
 7,103,511 B2 9/2006 Petite
 7,123,994 B2 10/2006 Weik et al.
 7,133,750 B2 11/2006 Raines et al.
 7,136,725 B1 11/2006 Paciorek et al.
 7,141,321 B2 11/2006 McArthur et al.
 7,142,949 B2 11/2006 Brewster et al.
 7,177,728 B2 2/2007 Gardner
 7,181,320 B2 2/2007 Whiffen et al.
 7,184,861 B2 2/2007 Petite
 7,200,134 B2 4/2007 Proctor, Jr. et al.
 7,206,670 B2 4/2007 Pimputkar et al.
 7,209,804 B2 4/2007 Curt et al.
 7,209,840 B2 4/2007 Petite et al.
 7,233,843 B2 6/2007 Budhreja et al.
 7,263,073 B2 8/2007 Petite et al.
 7,274,975 B2 9/2007 Miller
 7,289,887 B2 10/2007 Rodgers
 7,295,128 B2 11/2007 Petite
 7,305,282 B2 12/2007 Chen
 7,313,465 B1 12/2007 O'Donnell
 7,343,341 B2 3/2008 Sandor et al.
 7,345,998 B2 3/2008 Cregg et al.
 7,346,463 B2 3/2008 Petite et al.
 7,366,164 B1 4/2008 Habib et al.
 7,397,907 B2 7/2008 Petite
 7,406,364 B2 7/2008 Andren et al.
 7,412,304 B2 8/2008 Uenou
 7,424,527 B2 9/2008 Petite
 7,440,871 B2 10/2008 McConnell et al.
 7,451,019 B2 11/2008 Rodgers
 7,468,661 B2 12/2008 Petite et al.
 7,480,501 B2 1/2009 Petite
 7,486,681 B2 2/2009 Weber
 7,492,617 B2 2/2009 Petter et al.
 7,528,503 B2 5/2009 Rognli et al.
 7,536,240 B2 5/2009 McIntyre et al.
 7,541,941 B2 6/2009 Bogolea et al.
 7,565,227 B2 7/2009 Richard et al.
 7,650,425 B2 1/2010 Davis et al.
 7,697,492 B2 4/2010 Petite
 7,711,796 B2 5/2010 Gutt et al.
 7,715,951 B2 5/2010 Forbes et al.

(56)

References Cited

U.S. PATENT DOCUMENTS

7,738,999	B2	6/2010	Petite	2005/0240314	A1	10/2005	Martinez
7,739,378	B2	6/2010	Petite	2005/0240315	A1	10/2005	Booth et al.
8,010,812	B2	8/2011	Forbes, Jr. et al.	2005/0246190	A1	11/2005	Sandor et al.
8,032,233	B2	10/2011	Forbes, Jr. et al.	2005/0267642	A1	12/2005	Whiffen et al.
8,046,110	B2	10/2011	Mayor et al.	2005/0276222	A1	12/2005	Kumar et al.
8,145,361	B2	3/2012	Forbes, Jr. et al.	2005/0288954	A1	12/2005	McCarthy et al.
8,260,470	B2	9/2012	Forbes, Jr. et al.	2006/0020544	A1	1/2006	Kaveski
8,295,989	B2	10/2012	Rettger et al.	2006/0020596	A1	1/2006	Liu et al.
8,307,225	B2	11/2012	Forbes, Jr. et al.	2006/0022841	A1	2/2006	Hoiness et al.
8,315,717	B2	11/2012	Forbes, Jr. et al.	2006/0025891	A1	2/2006	Budike
8,359,124	B2	1/2013	Zhou et al.	2006/0031934	A1	2/2006	Kriegel
8,364,609	B2	1/2013	Ozog	2006/0064205	A1	3/2006	Ying
8,396,606	B2	3/2013	Forbes et al.	2006/0069616	A1	3/2006	Bau
8,417,569	B2	4/2013	Gross	2006/0106635	A1	5/2006	Ulrich et al.
8,457,802	B1	6/2013	Steven et al.	2006/0142900	A1	6/2006	Rothman et al.
8,463,449	B2	6/2013	Sanders	2006/0142961	A1	6/2006	Johnson et al.
8,473,111	B1	6/2013	Shankar et al.	2006/0161450	A1	7/2006	Carey et al.
8,527,107	B2	9/2013	Forbes et al.	2006/0168191	A1	7/2006	Ives
8,571,930	B1	10/2013	Galperin	2006/0190354	A1	8/2006	Meisel et al.
8,583,520	B1	11/2013	Forbes	2006/0195334	A1	8/2006	Reeb et al.
8,588,991	B1	11/2013	Forbes	2006/0212350	A1	9/2006	Ellis et al.
8,600,556	B2	12/2013	Nesler et al.	2006/0224615	A1	10/2006	Korn et al.
8,890,505	B2	11/2014	Forbes	2006/0271244	A1	11/2006	Cumming et al.
2001/0030468	A1	10/2001	Anderson et al.	2006/0271314	A1	11/2006	Hayes
2001/0038343	A1	11/2001	Meyer et al.	2006/0276938	A1	12/2006	Miller
2002/0019758	A1	2/2002	Scarpelli	2006/0282328	A1	12/2006	Gerace et al.
2002/0019802	A1	2/2002	Malme et al.	2007/0021874	A1	1/2007	Rognli et al.
2002/0035496	A1	3/2002	Fukushima et al.	2007/0038563	A1	2/2007	Ryzerski
2002/0036430	A1	3/2002	Welches et al.	2007/0058453	A1	3/2007	Shaffer et al.
2002/0109607	A1	8/2002	Cumeralto et al.	2007/0058629	A1	3/2007	Luft
2002/0138176	A1	9/2002	Davis et al.	2007/0070895	A1	3/2007	Narvaez
2002/0143693	A1	10/2002	Soestbergen et al.	2007/0085702	A1	4/2007	Walters et al.
2002/0161648	A1	10/2002	Mason et al.	2007/0091900	A1	4/2007	Asthana et al.
2002/0198629	A1	12/2002	Ellis	2007/0094043	A1	4/2007	Bannai et al.
2003/0009401	A1	1/2003	Ellis	2007/0100503	A1	5/2007	Balan et al.
2003/0009705	A1	1/2003	Thelander et al.	2007/0100961	A1	5/2007	Moore
2003/0036820	A1	2/2003	Yellepeddy et al.	2007/0150353	A1	6/2007	Krassner et al.
2003/0083980	A1	5/2003	Satake	2007/0156621	A1	7/2007	Wright et al.
2003/0144864	A1	7/2003	Mazzarella	2007/0156887	A1	7/2007	Wright et al.
2003/0149937	A1	8/2003	McElfresh et al.	2007/0174114	A1	7/2007	Bigby et al.
2003/0158632	A1	8/2003	Nierlich et al.	2007/0192333	A1	8/2007	Ali
2003/0176952	A1	9/2003	Collins et al.	2007/0203722	A1	8/2007	Richards et al.
2003/0225483	A1	12/2003	Santinato et al.	2007/0204176	A1	8/2007	Shaffer et al.
2003/0229572	A1	12/2003	Raines et al.	2007/0213878	A1	9/2007	Chen
2003/0233201	A1	12/2003	Horst et al.	2007/0214118	A1	9/2007	Schoen et al.
2004/0006439	A1	1/2004	Hunter	2007/0214132	A1	9/2007	Grubb et al.
2004/0024483	A1	2/2004	Holcombe	2007/0255457	A1	11/2007	Whitcomb et al.
2004/0044571	A1	3/2004	Bronnimann et al.	2007/0260540	A1	11/2007	Chau et al.
2004/0088083	A1	5/2004	Davis et al.	2007/0282495	A1	12/2007	Kempton et al.
2004/0107025	A1	6/2004	Ransom et al.	2007/0286210	A1	12/2007	Gutt et al.
2004/0117330	A1	6/2004	Ehlers et al.	2007/0291644	A1	12/2007	Roberts et al.
2004/0128266	A1	7/2004	Yellepeddy et al.	2007/0299562	A1	12/2007	Kates
2004/0153170	A1	8/2004	Santacatterina et al.	2008/0010212	A1	1/2008	Moore et al.
2004/0158478	A1	8/2004	Zimmerman	2008/0015976	A1	1/2008	Sandor et al.
2004/0162793	A1	8/2004	Scott et al.	2008/0040223	A1	2/2008	Bridges et al.
2004/0193329	A1	9/2004	Ransom et al.	2008/0091625	A1	4/2008	Kremen
2004/0225514	A1	11/2004	Greenshields et al.	2008/0104026	A1	5/2008	Koran
2004/0230533	A1	11/2004	Benco	2008/0109387	A1	5/2008	Deaver et al.
2005/0021397	A1	1/2005	Cui et al.	2008/0130673	A1	6/2008	Cregg et al.
2005/0033481	A1	2/2005	Budhraj et al.	2008/0147465	A1	6/2008	Raines et al.
2005/0055432	A1	3/2005	Rodgers	2008/0154801	A1	6/2008	Fein et al.
2005/0065742	A1	3/2005	Rodgers	2008/0165714	A1	7/2008	Dettinger et al.
2005/0080772	A1	4/2005	Bern	2008/0172312	A1	7/2008	Synesiou et al.
2005/0096856	A1	5/2005	Lubkeman et al.	2008/0177423	A1	7/2008	Brickfield et al.
2005/0096857	A1	5/2005	Hunter	2008/0177678	A1	7/2008	Martini et al.
2005/0096979	A1	5/2005	Koningstein	2008/0195462	A1	8/2008	Magdon-Ismail et al.
2005/0097204	A1	5/2005	Horowitz et al.	2008/0224892	A1	9/2008	Bogolea et al.
2005/0125243	A1	6/2005	Villalobos	2008/0231114	A1	9/2008	Tolnar et al.
2005/0127680	A1	6/2005	Lof et al.	2008/0238710	A1	10/2008	Tolnar et al.
2005/0138432	A1	6/2005	Ransom et al.	2008/0249832	A1	10/2008	Richardson et al.
2005/0192711	A1	9/2005	Raines et al.	2008/0255899	A1	10/2008	McConnell et al.
2005/0192713	A1	9/2005	Weik et al.	2008/0263025	A1	10/2008	Koran
2005/0216302	A1	9/2005	Raji et al.	2008/0270223	A1	10/2008	Collins et al.
2005/0216580	A1	9/2005	Raji et al.	2008/0281473	A1	11/2008	Pitt
2005/0234600	A1	10/2005	Boucher et al.	2008/0306824	A1	12/2008	Parkinson
				2008/0306830	A1	12/2008	Lasa et al.
				2008/0319893	A1	12/2008	Mashinsky et al.
				2009/0012996	A1	1/2009	Gupta et al.
				2009/0018884	A1	1/2009	McConnell et al.

(56)

References Cited

FOREIGN PATENT DOCUMENTS

U.S. PATENT DOCUMENTS

2009/0024718 A1 1/2009 Anagnostopoulos et al.
 2009/0038343 A1 2/2009 Gibson
 2009/0043519 A1 2/2009 Bridges et al.
 2009/0043520 A1 2/2009 Pollack et al.
 2009/0045804 A1 2/2009 Durling et al.
 2009/0055031 A1 2/2009 Slota et al.
 2009/0062970 A1 3/2009 Forbes et al.
 2009/0063228 A1 3/2009 Forbes
 2009/0088907 A1 4/2009 Lewis et al.
 2009/0112701 A1 4/2009 Turpin et al.
 2009/0112758 A1 4/2009 Herzig
 2009/0124241 A1 5/2009 Krishnaswamy et al.
 2009/0125462 A1 5/2009 Krishnaswamy et al.
 2009/0135836 A1 5/2009 Veillette
 2009/0138362 A1 5/2009 Schroedl et al.
 2009/0187344 A1 7/2009 Brancaccio et al.
 2009/0187499 A1 7/2009 Mulder et al.
 2009/0198384 A1 8/2009 Ahn
 2009/0228335 A1 9/2009 Niyogi et al.
 2009/0240381 A1 9/2009 Lane
 2009/0240677 A1 9/2009 Parekh et al.
 2009/0281673 A1 11/2009 Taft
 2009/0281674 A1 11/2009 Taft
 2009/0319415 A1 12/2009 Stoilov et al.
 2010/0076835 A1 3/2010 Silverman
 2010/0082464 A1 4/2010 Keefe
 2010/0106575 A1 4/2010 Bixby et al.
 2010/0106641 A1 4/2010 Chassin et al.
 2010/0138452 A1 6/2010 Henkin et al.
 2010/0169175 A1 7/2010 Koran
 2010/0191862 A1 7/2010 Forbes, Jr. et al.
 2010/0217452 A1 8/2010 McCord et al.
 2010/0217549 A1 8/2010 Galvin et al.
 2010/0217550 A1 8/2010 Crabtree et al.
 2010/0217642 A1 8/2010 Crubtree et al.
 2010/0218108 A1 8/2010 Crabtree et al.
 2010/0235008 A1 9/2010 Forbes, Jr. et al.
 2010/0274407 A1 10/2010 Creed
 2010/0293045 A1 11/2010 Burns et al.
 2010/0306033 A1 12/2010 Oved et al.
 2010/0332373 A1 12/2010 Crabtree et al.
 2011/0025556 A1 2/2011 Bridges et al.
 2011/0055036 A1 3/2011 Helfan
 2011/0060474 A1 3/2011 Schmiegel et al.
 2011/0080044 A1 4/2011 Schmiegel
 2011/0106729 A1 5/2011 Billingsley et al.
 2011/0115302 A1 5/2011 Slota et al.
 2011/0133655 A1 6/2011 Recker et al.
 2011/0145061 A1 6/2011 Spurr et al.
 2011/0161250 A1 6/2011 Koeppe et al.
 2011/0172841 A1 7/2011 Forbes, Jr.
 2011/0178610 A1 7/2011 Gamble et al.
 2011/0185303 A1 7/2011 Katagi et al.
 2011/0196546 A1 8/2011 Muller et al.
 2011/0204717 A1 8/2011 Shaffer
 2011/0208366 A1 8/2011 Taft
 2011/0235656 A1 9/2011 Pigeon
 2011/0251730 A1 10/2011 Pitt
 2011/0257809 A1 10/2011 Forbes, Jr. et al.
 2011/0258022 A1 10/2011 Forbes, Jr. et al.
 2012/0196482 A1 8/2012 Stokoe
 2012/0205977 A1 8/2012 Shin et al.
 2012/0221162 A1 8/2012 Forbes, Jr.
 2012/0223840 A1 9/2012 Guymon et al.
 2012/0232816 A1 9/2012 Oh et al.
 2012/0239219 A1 9/2012 Forbes
 2012/0259760 A1 10/2012 Sgouridis et al.
 2012/0296799 A1 11/2012 Playfair et al.
 2012/0316697 A1 12/2012 Boardman et al.
 2013/0035802 A1 2/2013 Khaitan et al.
 2013/0079939 A1 3/2013 Darden, II et al.
 2013/0079943 A1 3/2013 Darden, II et al.
 2013/0144768 A1 6/2013 Rohrbaugh
 2014/0025486 A1 1/2014 Bigby et al.
 2014/0039703 A1 2/2014 Forbes

JP 2001306839 A 11/2001
 JP 2004180412 A 6/2004
 JP 2004248174 A 9/2004
 JP 2006060911 A 3/2006
 JP 2007132553 A 5/2007
 KR 2005001584 1/2005
 KR 2006001584 1/2005
 KR 20050045272 A 5/2005
 KR 20060036171 A 4/2006
 KR 20070008321 A 1/2007
 KR 100701298 B1 3/2007
 KR 20070098172 A 10/2007
 KR 20080112692 A 12/2008
 WO 2007136456 A 11/2007
 WO 2008125696 A 10/2008

OTHER PUBLICATIONS

B.J. Kirby, Spinning Reserve from Responsive Loads, Oak Ridge National Laboratory, United States Dept. of Energy, Mar. 2003 (54 pages).

Byers J. Risk Management and Monetizing the Commodity Storage Option. *Natural Gas & Electricity* [serial online]. Jul. 2005; 21 (12):1-8. Available from: Business Source Complete, Ipswich, MA. C.W. Gellings and W.M. Smith, Integrating Demand-Side Management into Utility Planning, *Proceedings of the IEEE*, vol. 77, Issue: 6, Jun. 1989, pp. 908-918 (Abstract only).

Eric Hirst and Brendan Kirby, Opportunities for Demand Participation in New England Contingency-Reserve Markets, *New England Demand Response Initiative*, Feb. 2003 (15 pages).

Eric Hirst and Richard Cowart, Demand Side Resources and Reliability, *New England Demand Response Initiative*, Mar. 20, 2002 (32 pages).

Galvin Electricity Institute: Frequently Asked Questions, printed Apr. 23, 2014, same page available through archive.org unchanged Mar. 1, 2008.

GE Digital Energy Residential Electrical Metering Brochure. Sep. 12, 2012. <https://web.archive.org/web/20120912144353/http://www.gedigitalenergy.com/products/brochures/1210-Family.pdf>.

Illinois General Assembly: Public Act 094-0977, Effective Date: Jun. 30, 2006.

International Search Report and Written Opinion dated Dec. 20, 2010 issued by the United States Patent and Trademark Office as International Searching Authority in connection with related International Application No. PCT/US10/02676 (20 pages).

International Search Report and Written Opinion dated Dec. 21, 2010 issued by the Korean Intellectual Property Office as International Searching Authority in connection with related International Application No. PCT/US2010/034247 (7 pages).

International Search Report and Written Opinion dated Dec. 22, 2010 issued by the Korean Intellectual Property Office as International Searching Authority in connection with related International Application No. PCT/US2010/034418 (7 pages).

International Search Report and Written Opinion dated Dec. 22, 2010 issued by the Korean Intellectual Property Office as International Searching Authority in connection with related International Application No. PCT/US2010/034409 (7 pages).

International Search Report and Written Opinion dated Feb. 25, 2009 issued by the Korean Intellectual Property Office as International Searching Authority in connection with international Application No. PCT/US2008/01099 (7 pages).

International Search Report and Written Opinion dated Feb. 25, 2009 issued by the Korean Intellectual Property Office as International Searching Authority in connection with International Application No. PCT/US2008/010199 (7 pages).

International Search Report and Written Opinion dated Jul. 15, 2010 issued by the United States Patent and Trademark Office as International Searching Authority in connection with International Application No. PCT/US10/01354 (10 pages).

International Search Report and Written Opinion dated Jul. 23, 2010 issued by the United States Patent and Trademark Office as Inter-

(56)

References Cited

OTHER PUBLICATIONS

national Searching Authority in connection with International Application No. PCT/US10/01489 (11 pages).

International Search Report and Written Opinion dated Mar. 6, 2009 issued by the United States Patent and Trademark Office as International Searching Authority in connection with related International Application No. PCT/US10/010200 (8 pages).

International Search Report and Written Opinion dated May 31, 2011 issued by the Korean Intellectual Property Office as International Searching Authority in connection with related International Application No. PCT/US2010/002709 (7 pages).

International Search Report and Written Opinion dated Nov. 30, 2010 issued by the Korean Intellectual Property Office as International Searching Authority in connection with related International Application No. PCT/US2010/034395 (8 pages).

Kamat R., Oren S. Two-Settlement Systems for Electricity Markets under Network Uncertainty and Market Power *Journal of Regulatory Economics* [serial online]. Jan. 2004; 25(1):5-37.

Kathleen Spees and Lester B. Lave, Demand Response and Electricity Market Efficiency, *The Electricity Journal*, vol. 20, Issue 3, Apr. 2007 (online Mar. 27, 2007), pp. 69-85 (Abstract only).

L.T. Anstine, R.E. Burke, J.E. Casey, R. Holgate, R.S. John, and H.G. Stewart, Application of Probability Methods to the Determination of Spinning Reserve Requirements for the Pennsylvania-New Jersey-Maryland Interconnection; *IEEE Transactions on Power Apparatus and Systems*, vol. 82, Issue 68, Oct. 1963, pp. 726-735 (Abstract only).

Lobsenz G. Maryland Regulators Reject BG&E Smart Grid Proposal. *Energy Daily* [serial online]. Jun. 23, 2010; (118): 3. Available from: Business Source Complete, Ipswich, MA.

M. Rashidi-Nejad, Y.H. Song, and M.H. Javidi-Dasht-Bayaz, Operating Reserve Provision in Deregulated Power Markets, *IEEE Power Engineering Society Winter Meeting*, vol. 2, 2002, pp. 1305-1310 (Abstract only).

Mashiro Inoue, Toshiyasu Higuma, Yoshiaki Ito, Noriyuki Kushiro and Hitoshi Kubota, Network Architecture for Home Energy Management System, *IEEE Transactions on Consumer Electronics*, vol. 49, Issue 3, Aug. 2003, pp. 606-613 (8 pages).

Michael Ahlheim and Friedrich Schneider; "Allowing for Household Preferences in Emission Trading, A Contribution to the Climate Policy Debate"; *Environmental and Resource Economics*, vol. 21, pp. 317-342; Kluwer Academic Publishers; The Netherlands; 2002.

Notice of Allowability dated Aug. 31, 2010, as entered in related U.S. Appl. No. 12/715,124 (5 pages).

Notice of Allowability dated Dec. 23, 2009, U.S. Appl. No. 11/895,909 (4 pages).

Office Action dated Jan. 7, 2011 as issued by the Australian Patent Office (Australian Government IP Australia) in connection with related Australian Application No. 2008296979 (2 pages).

Office Action dated Jul. 17, 2009, U.S. Appl. No. 11/895,909 (11 pages).

Office Action dated May 10, 2011 as issued by the Japanese Patent Office in connection with counterpart Japanese Application No. 2010/522953 (3 pages).

Olivier Rousse; "Environmental and economic benefits resulting from citizens' participation in CO.sub.2 emissions trading: An efficient alternative solution to the voluntary compensation of CO.sub.2 emissions", *Energy Policy* 36 (2008), pp. 388-397; Oct. 29, 2007 (online).

Pablo A. Ruiz and Peter W. Sauer, Valuation of Reserve Services, *IEEE Proceedings of the 41 .sup.st Hawaii International Conference on System Sciences*, 2008 (9 pages).

Paul Darbee, Insteon Compared, SmartLabs, Inc., Jan. 2, 2006, 69 pages.

Paul Darbee, Insteon the Details, Smarthome, Inc., Aug. 11, 2005, 68 pages.

Zhu Jinxiang, G. Jordan, and S. Ihara, The Market for Spinning Reserve and Its Impacts on Energy Prices, *IEEE Power Engineering Society Winter Meeting*, vol. 2, 2000, pp. 1202-1207 (Abstract Only).

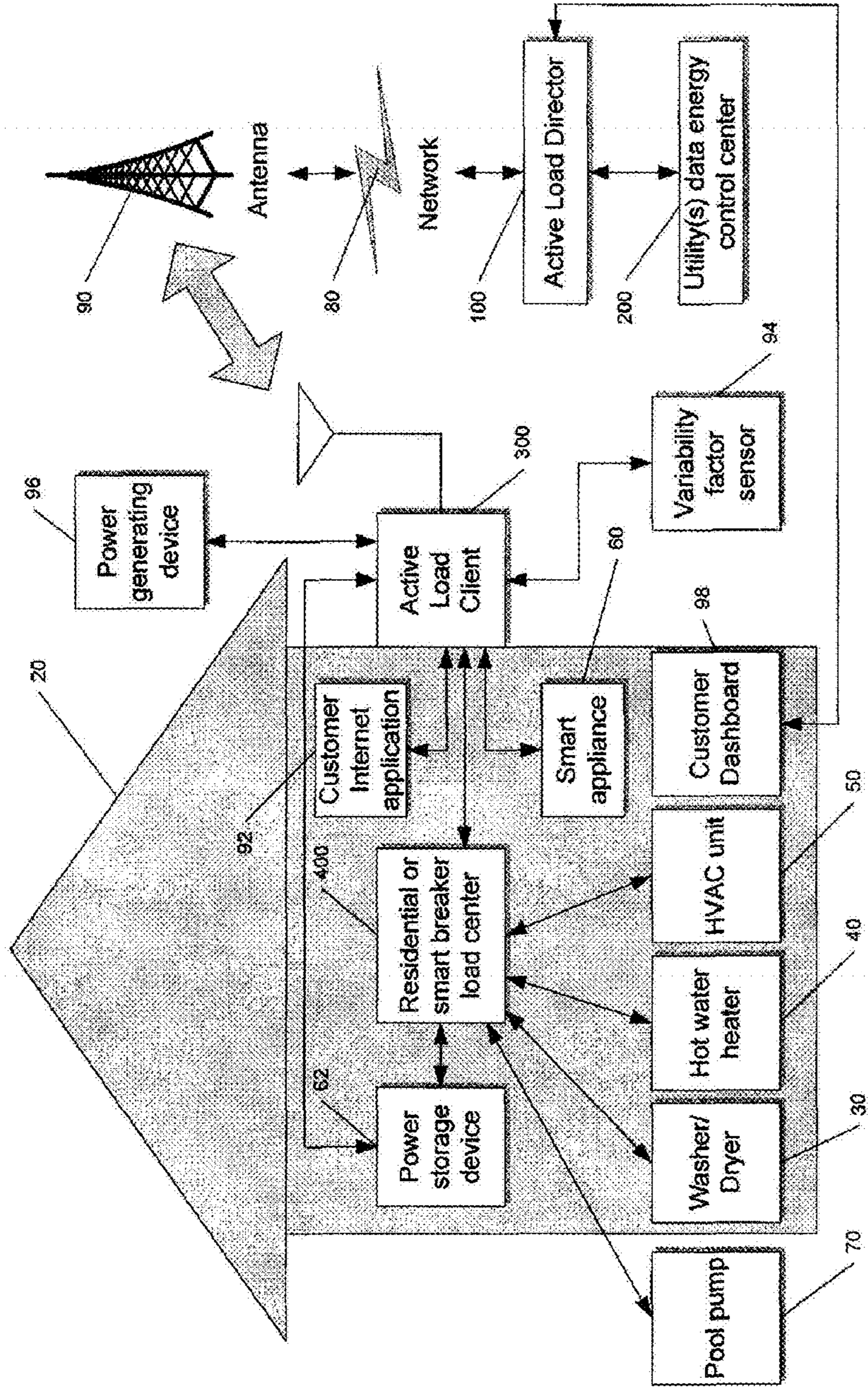


FIG. 1

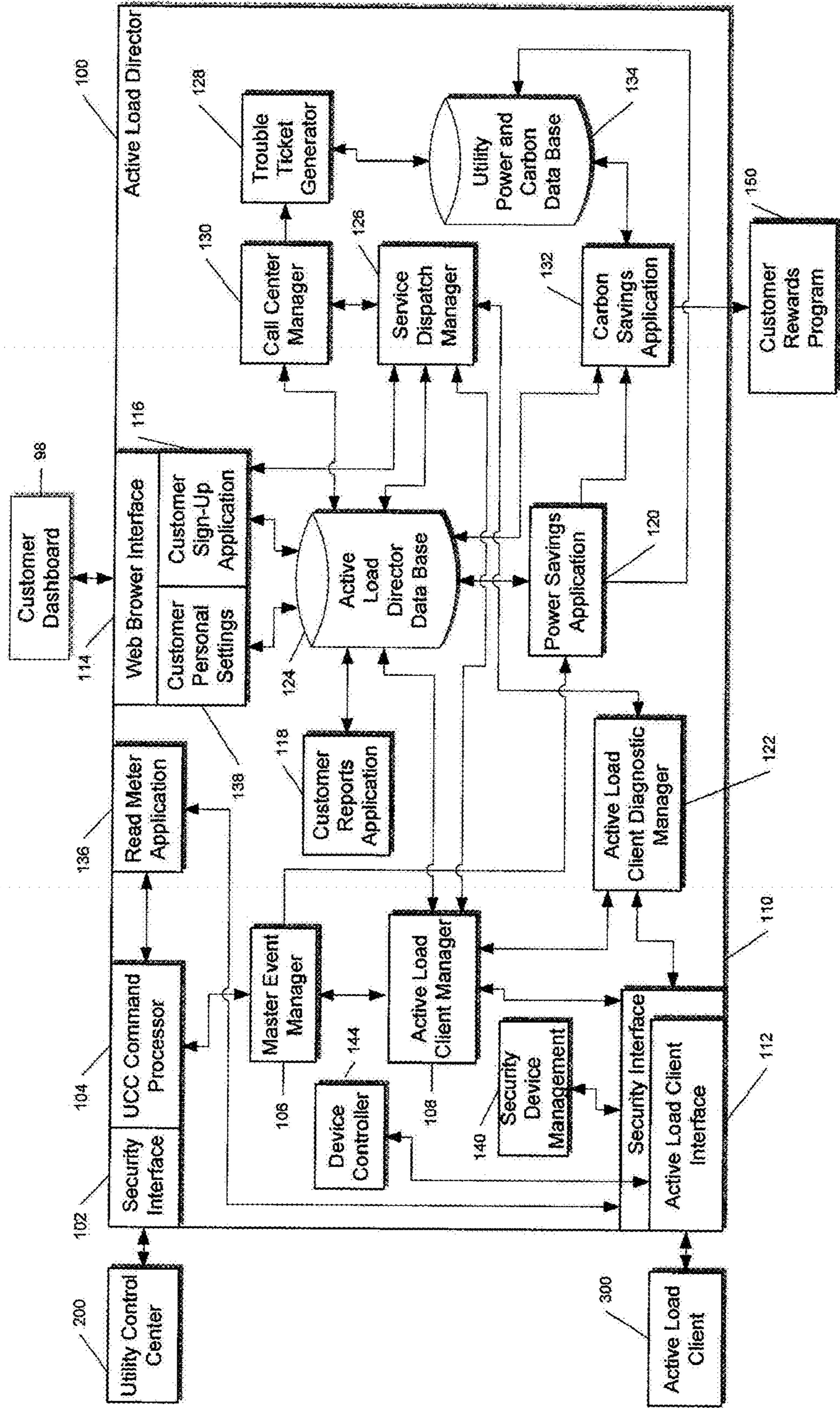


FIG. 2

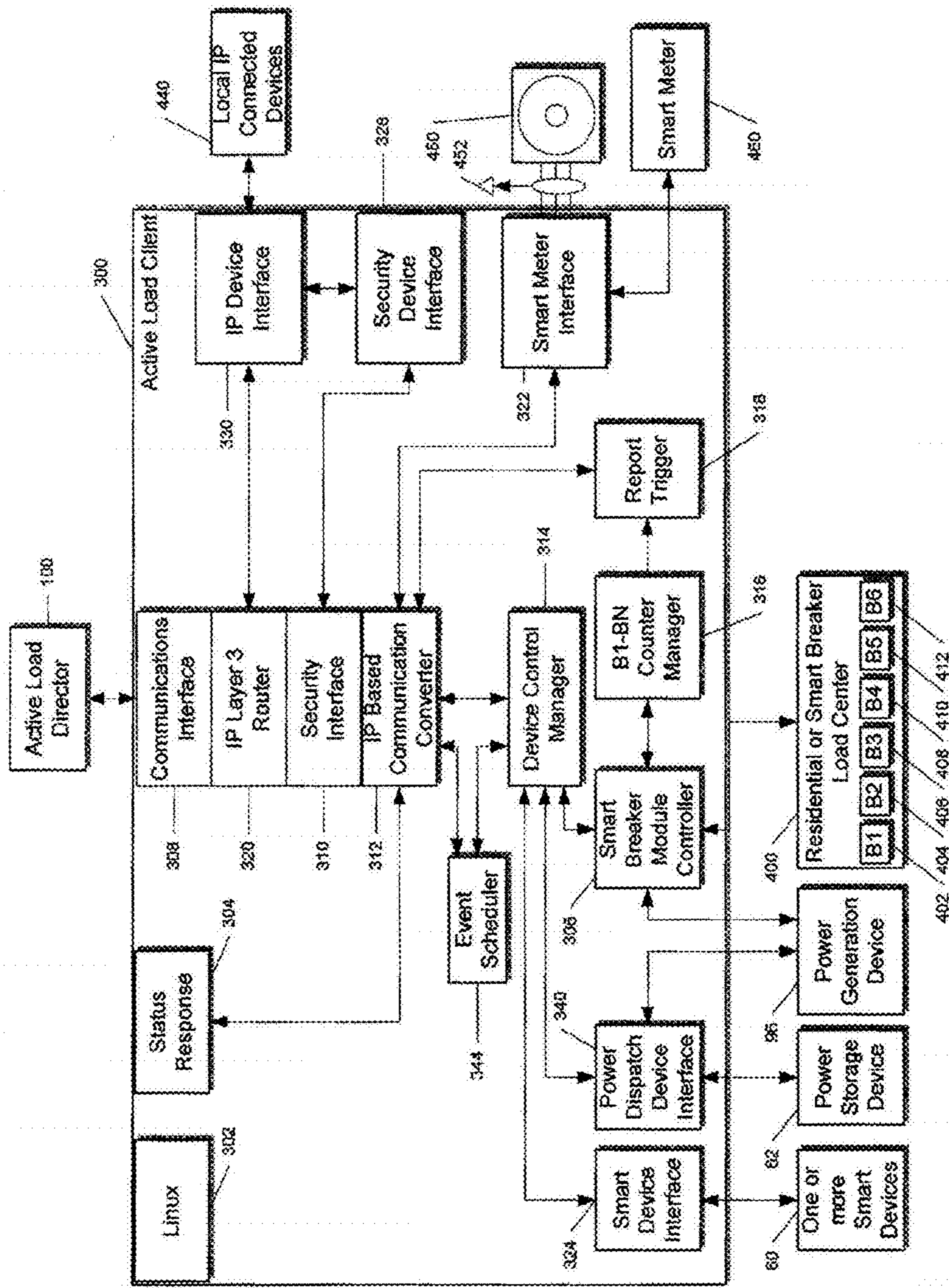
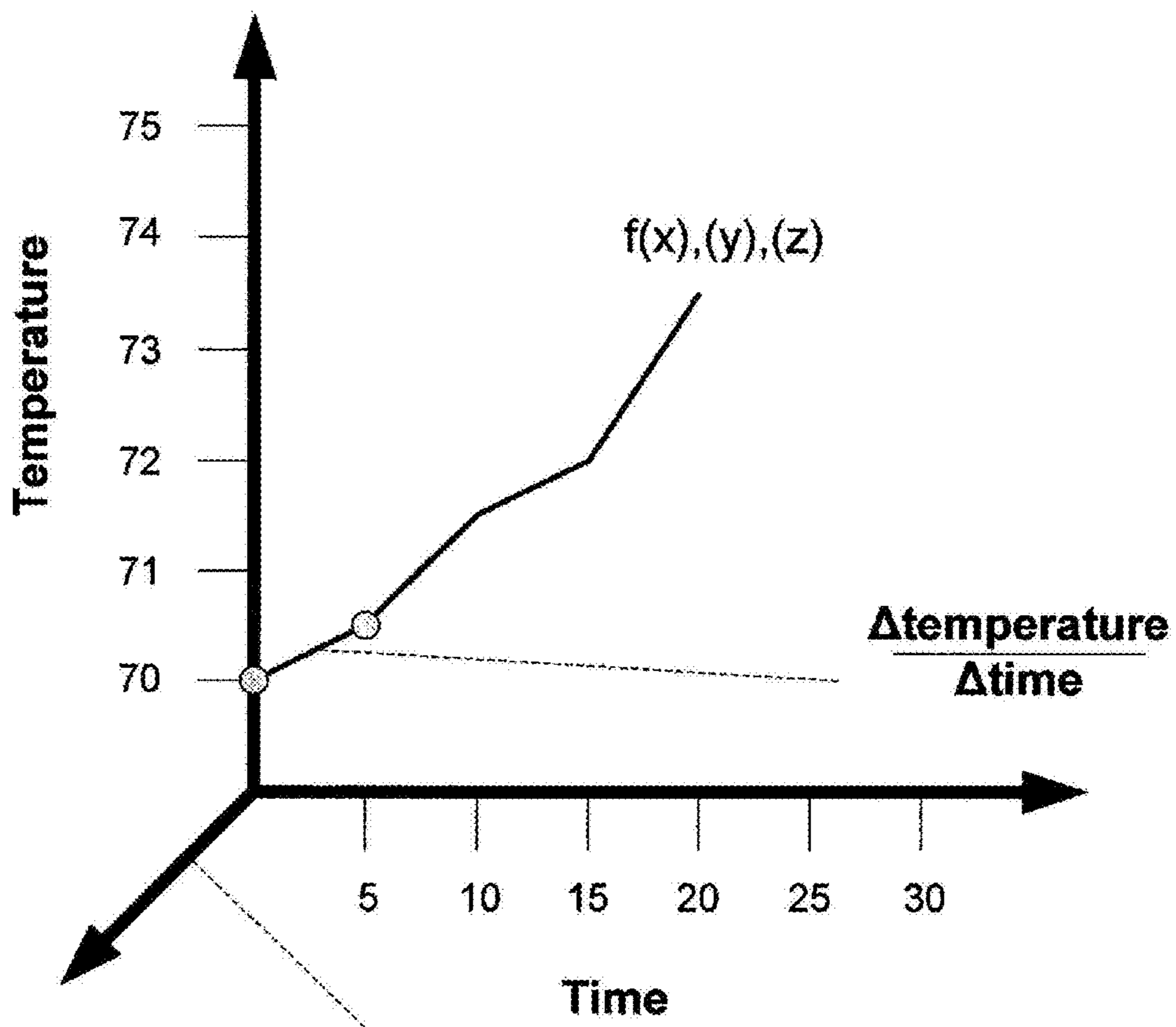


FIG. 3



This is not just a 3rd dimension. There could be many additional dimensions based on climate factors such as humidity, outside temperature, etc.

FIG. 4

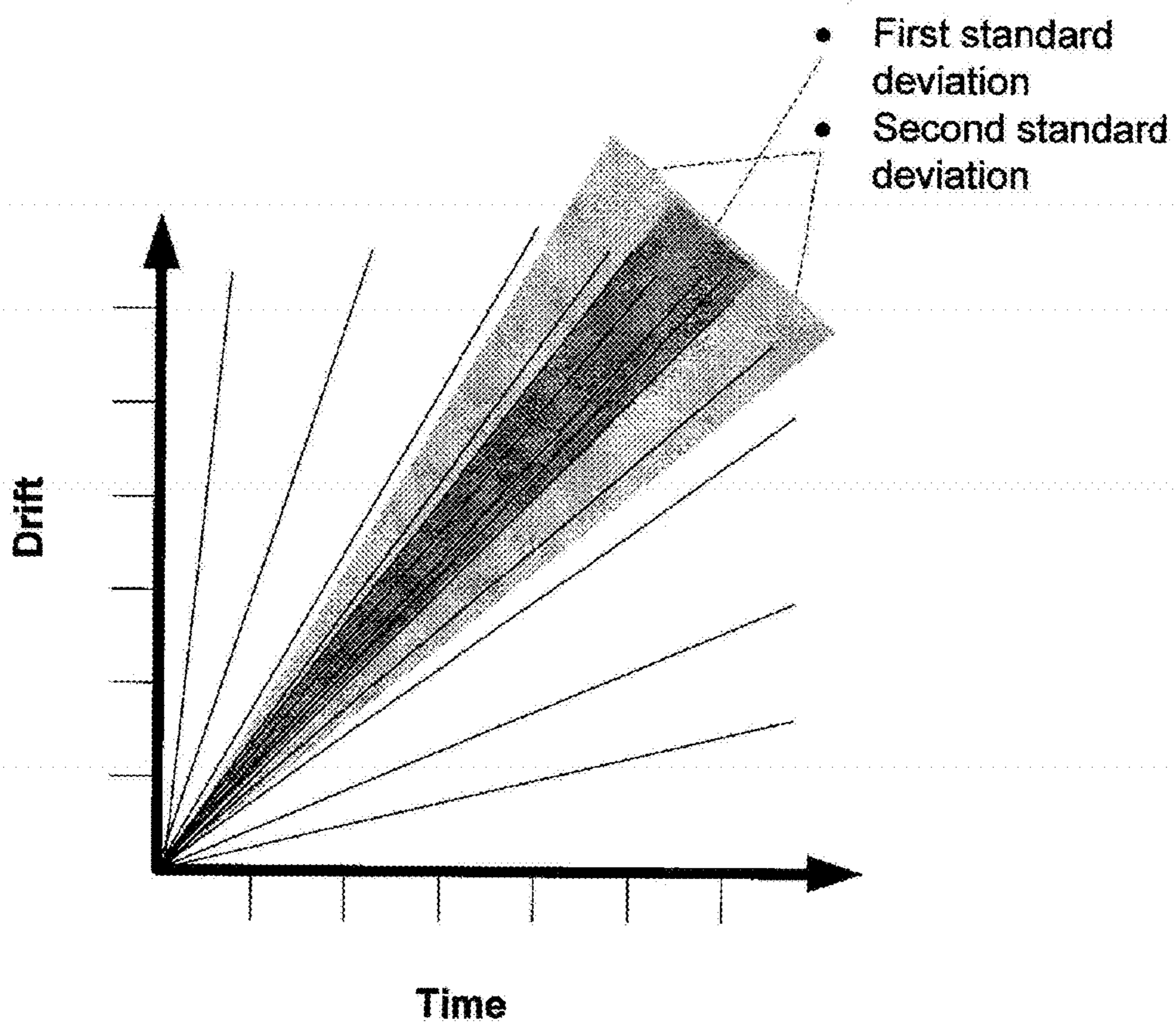


FIG. 5

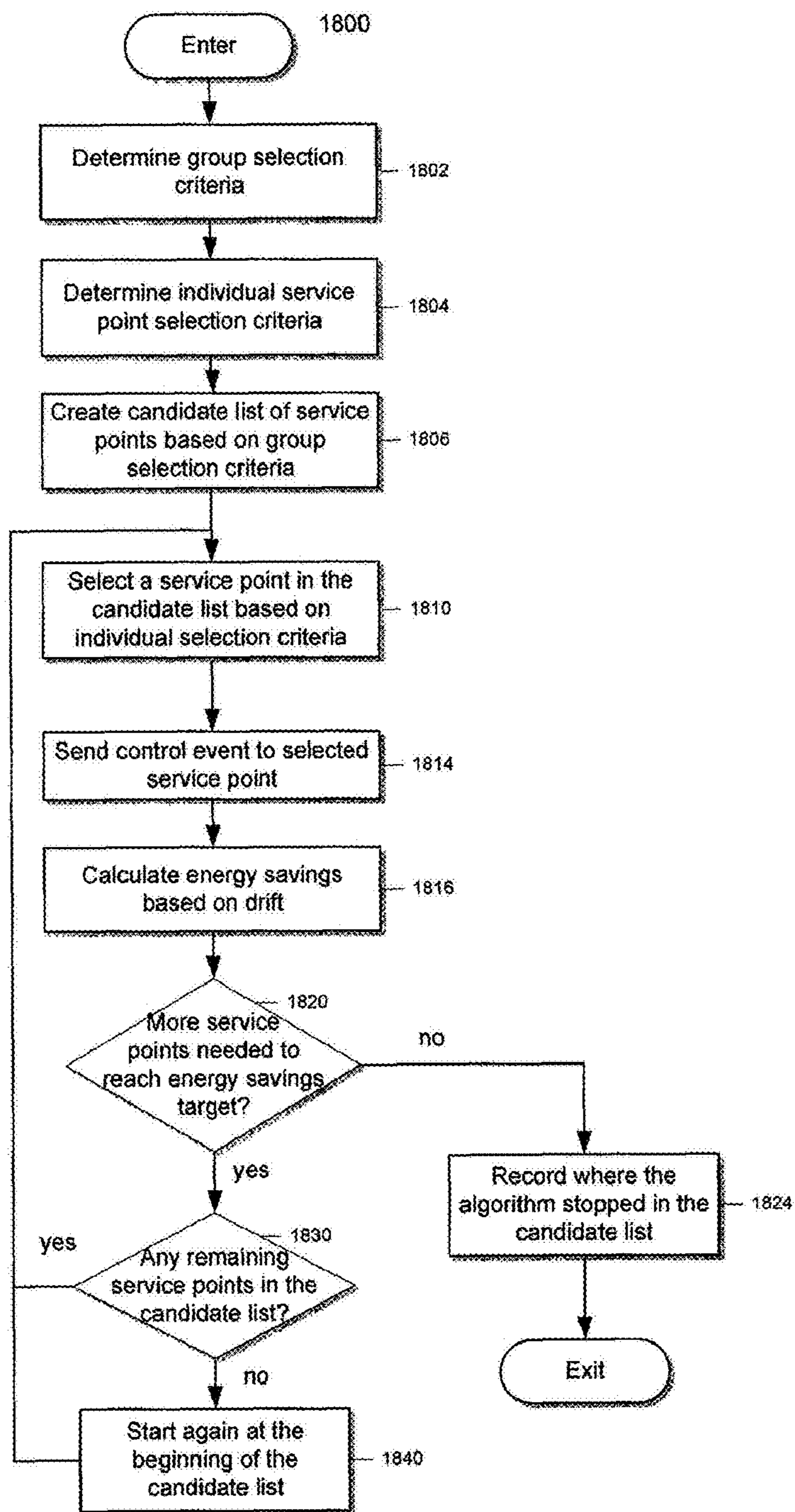


FIG. 6

**SYSTEMS AND METHODS FOR
DETERMINING AND UTILIZING
CUSTOMER ENERGY PROFILES FOR LOAD
CONTROL FOR INDIVIDUAL STRUCTURES,
DEVICES, AND AGGREGATION OF SAME**

CROSS-REFERENCE TO RELATED
APPLICATIONS

This non-provisional utility patent application claims priority from and is a continuation of U.S. application Ser. No. 13/464,665, filed May 4, 2012, which is a continuation-in-part of U.S. application Ser. No. 13/019,867, now U.S. Pat. No. 8,996,183, filed Feb. 2, 2011, and is a continuation-in-part of U.S. application Ser. No. 12/896,307, now U.S. Pat. No. 8,527,107, filed on Oct. 1, 2010, which are both continuations-in-part of U.S. application Ser. No. 12/702,640, now U.S. Pat. No. 8,131,403, filed Feb. 9, 2010, which is a continuation-in-part of U.S. application Ser. No. 11/895,909, now U.S. Pat. No. 7,715,951, filed Aug. 28, 2007, each of which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to electrical power load control systems and, more particularly, to creating customer profiles using energy consumption patterns.

2. Description of Related Art

Customer profiles are often used by systems for a variety of reasons. One reason is to promote customer loyalty. This involves keeping information about not only the customer, but about the customer's actions as well. This may include information about what the customer owns (i.e., which devices), how they are used, when they are used, etc. By mining this data, a company can more effectively select rewards for customers that give those customers an incentive for continuing to do business with the company. This is often described as customer relationship management (CRM).

Customer profile data is also useful for obtaining feedback about how a product is used. In software systems, this is often used to improve the customer/user experience or as an aid to testing. Deployed systems that have customer profiling communicate customer actions and other data back to the development organization. That data is analyzed to understand the customer's experience. Lessons learned from that analysis is used to make modifications to the deployed system, resulting in an improved system.

Customer profile data may also be used in marketing and sales. For instance, a retail business may collect a variety of information about a customer, including what customers look at on-line and inside "brick-and-mortar" stores. This data is mined to try to identify customer product preferences and shopping habits. Such data helps sales and marketing determine how to present products of probable interest to the customer, resulting in greater sales.

However, the collection of customer profile information by power utilities has been limited to customer account information. Because power utilities typically are unable to collect detailed data about what is happening inside a customer's home or business, including patterns of energy consumption by device, there has been little opportunity to create extensive customer profiles.

SUMMARY OF THE INVENTION

Embodiments described herein utilize the Active Load Management System (ALMS) that is fully described in

commonly-owned published patent application US 2009/0062970. The ALMS captures energy usage data at each service point and stores that data in a central database. This data describes all of the energy consumed by devices owned by each customer, as well as additional information, such as customer preferences. Other embodiments of the ALMS focus on use of this information in the calculation of carbon credits or for the trading of unused energy.

In one embodiment, a system and method are provided for creating and making use of customer profiles, including energy consumption patterns. Devices within a service point, using the active load director, may be subject to control events, often based on customer preferences. These control events cause the service point to use less power. Data associated with these control events, as well as related environment data, are used to create an energy consumption profile for each service point. This can be used by the utility to determine which service points are the best targets for energy consumption. In addition, an additional algorithm determines how to prevent the same service points from being picked first each time the utility wants to conserve power.

In one embodiment, a method is provided for determining and using customer energy profiles to manage electrical load control events on a communications network between a server in communication with an electric utility and a client device at each of a plurality of service points. A customer profile is generated at the server for each of a plurality of customers including at least energy consumption information for a plurality of controllable energy consuming devices at an associated service point. The plurality of customer profiles is stored in a database at the server for use in load control events. The plurality of customer profiles are aggregated into a plurality of groups based on at least one predetermined criterion. A candidate list of service points for load control events based on the predetermined criterion is generated at the server. A load control event is sent to at least one selected service point in the candidate list of service points in response to an energy reduction request including a target energy savings received from the electric utility via the communications network. An energy savings for the plurality of controllable energy consuming devices resulting from the load control event at the selected service point is determined at the server. The server determines if the resulting energy savings is at least equal to the target energy savings. The load control event is sent to at least one selected additional service point in the candidate list of service points in order to reach the target energy savings, if the target energy savings has not been reached.

In one embodiment, a system is provided for determining and using customer energy profiles to manage electrical load control events on a communications network between a server in communication with an electric utility and a client device at each of a plurality of service points. The system includes a memory storing a database containing a plurality of customer profiles for load control events wherein each customer profile includes at least energy consumption information for a plurality of controllable energy consuming devices at an associated service point; and a server processor, cooperative with the memory, and configured for managing electrical load control events on the communications network to the plurality of service points by: generating a customer profile for each of a plurality of customers; aggregating the plurality of customer profiles into a plurality of groups based on at least one predetermined criterion; generating a candidate list of service points for load control events based on the predetermined criterion; sending a load

control event to at least one selected service point in the candidate list of service points in response to an energy reduction request including a target energy savings received from the electric utility via the communications network; determining an energy savings for the plurality of controllable energy consuming devices resulting from the load control event at the selected service point; determining if the resulting energy savings is at least equal to the target energy savings; and sending the load control event to at least one selected additional service point in the candidate list of service points in order to reach the target energy savings.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other advantages and aspects of the embodiments of the invention will become apparent and more readily appreciated from the following detailed description of the embodiments taken in conjunction with the accompanying drawings, as follows.

FIG. 1 is a block diagram of an exemplary IP-based, Active Load Management System (ALMS).

FIG. 2 is a block diagram illustrating an exemplary active load director (ALD) server included in the active load management system.

FIG. 3 is a block diagram illustrating an exemplary active load client (ALC) included in the active load management system.

FIG. 4 is a graph illustrating how drift is calculated.

FIG. 5 is a graph illustrating how service points are selected for optimal drift.

FIG. 6 is an operational flow diagram illustrating an exemplary Intelligent Load Rotation algorithm.

DETAILED DESCRIPTION

Before describing in detail exemplary embodiments, it should be observed that the embodiments described reside primarily in combinations of apparatus components and processing steps related to actively managing power loading on an individual subscriber or service point basis, determining the customer profile of individual devices aggregated to related service points, and optionally tracking power savings incurred by both individual subscribers and an electric utility. Accordingly, the apparatus components and method steps have been represented where appropriate by conventional symbols in the drawings, showing only those specific details that are pertinent to understanding the embodiments disclosed so as not to obscure the disclosure with details that will be readily apparent to those of ordinary skill in the art having the benefit of the description herein.

The term “electric utility” refers to any entity that generates and distributes electrical power to its customers, that purchases power from a power-generating entity and distributes the purchased power to its customers, or that supplies electricity created by alternative energy sources, such as solar power, wind power or otherwise, to power generation or distribution entities through the Federal Energy Regulatory Commission (FERC) electrical grid or otherwise. The present invention provides for systems and methods relating to an electric grid operator or any market participant associated with an electric grid, including retail electrical providers.

Embodiments of the invention include a number of novel concepts, including a customer profile, drift, and intelligent load rotation as more fully described below. A customer profile captures patterns of power consumption for each customer. The drift concept includes a method for calculat-

ing drift, which is important in estimating power savings within thermal control devices. The intelligent load rotation concept includes a method for selecting customers for utility-initiated control events using intelligent load rotation.

The embodiments described utilize concepts disclosed in commonly-owned published patent application US 2009/0062970, entitled “System and Method for Active Power Load Management” which is incorporated by reference in its entirety herein. The following paragraphs describe the Active Management Load System (ALMS), Active Load Director (ALD), and Active Load Client (ALC) in sufficient detail to assist the reader in the understanding of the embodiments described herein. More detailed description of the ALMS, ALD, and ALC can be found in US 2009/0062970.

It should be noted that control events and other messaging used in embodiments of the invention include regulated load management messages. Regulated load management messages contain information used to apply control of the electric supply to individual appliances or equipment on customer premises. The load to be controlled includes native load and operating reserves including regulating, spinning, and non-spinning types.

Active Load Management System

FIG. 1 depicts an exemplary IP-based Active Load Management System (ALMS) 10 that may be utilized by a utility in the embodiments described herein. The exemplary ALMS 10 monitors and manages power distribution via an active load director (ALD) 100 connected between one or more utility control centers (UCCs) 200 and one or more Active Load Clients (ALCs) 300. The ALD 100 may communicate with the utility control center 200 and each active load client 300 either directly or through a network 80 using the Internet Protocol (IP) or any other connection-based protocols. For example, the ALD 100 may communicate using RF systems operating via one or more base stations 90 using one or more well-known wireless communication protocols. Alternatively, or additionally, the ALD 100 may communicate via a digital subscriber line (DSL) capable connection, cable television based IP capable connection, or any combination thereof. In the exemplary embodiment shown in FIG. 1, the ALD 100 communicates with one or more active load clients 300 using a combination of traditional IP-based communication (e.g., over a trunked line) to a base station 90 and a wireless channel implementing the WiMax protocol for the “last mile” from the base station 90 to the active load client 300.

Each ALC 300 is accessible through a specified address (e.g., IP address) and controls and monitors the state of individual smart breaker modules or intelligent appliances 60 installed in the business or residence 20 to which the ALC 300 is associated (e.g., connected or supporting). Each ALC 300 is associated with a single residential or commercial customer. In one embodiment, the ALC 300 communicates with a residential load center 400 that contains smart breaker modules, which are able to switch from an “ON” (active) state to an “OFF” (inactive) state, and vice versa, responsive to signaling from the ALC 300. Typically, each smart breaker controls a single appliance (e.g., a washer/dryer 30, a hot water heater 40, an HVAC unit 50, or a pool pump 70).

Additionally, the ALC 300 may control individual smart appliances directly (e.g., without communicating with the residential load center 400) via one or more of a variety of known communication protocols (e.g., IP, Broadband over Power Line (BPL) in various forms, including through specifications promulgated or being developed by the HOMEPLUG Powerline Alliance and the Institute of Electrical and Electronics Engineers (IEEE), Ethernet, Blu-

etooth, ZigBee, Wi-Fi, WiMax, etc.). Additionally or alternatively to WiMax, other communications protocols may be used, including but not limited to a “1G” wireless protocol such as analog wireless transmission, first generation standards based (IEEE, ITU or other recognized world communications standard), a “2-G” standards based protocol such as “EDGE or CDMA 2000 also known as 1xRTT”, a 3G based standard such as “High Speed Packet Access (HSPA) or Evolution for Data Only (EVDO), any accepted 4G standard such as “IEEE, ITU standards that include WiMax, Long Term Evolution “LTE” and its derivative standards, any Ethernet solution wireless or wired, or any proprietary wireless or power line carrier standards that communicate to a client device or any controllable device that sends and receives an IP based message.

Typically, a smart appliance **60** includes a power control module (not shown) having communication abilities. The power control module is installed in-line with the power supply to the appliance, between the actual appliance and the power source (e.g., the power control module is plugged into a power outlet at the home or business and the power cord for the appliance is plugged into the power control module). Thus, when the power control module receives a command to turn off the appliance **60**, it disconnects the actual power supplying the appliance **60**. Alternatively, a smart appliance **60** may include a power control module integrated directly into the appliance, which may receive commands and control the operation of the appliance directly (e.g., a smart thermostat may perform such functions as raising or lowering the set temperature, switching an HVAC unit on or off, or switching a fan on or off).

Also as shown in FIG. 1, a service point **20** may have its own power generation on-site, including solar panels, fuel cells, or wind turbines. This is indicated by the power generating device **96**. The power generating device **96** connects to the Active Load Client **300**. Power that is added by the power generating device **96** is added to the overall utility capacity. The utility provides credit to the service point owner based on the energy produced at the service point.

The service point **20** also contains the Customer Dashboard **98**. This is a web-based interface used by the customer to specify preferences for the use of the Active Load Management System at the customer’s service point. These preferences include control event preferences, bill management preferences, and others.

Active Load Director

Referring now to FIG. 2, the ALD **100** may serve as the primary interface to customers, as well as to service personnel. In the exemplary embodiment depicted in FIG. 2, the ALD **100** includes a utility control center (UCC) security interface **102**, a UCC command processor **104**, a master event manager **106**, an ALC manager **108**, an ALC security interface **110**, an ALC interface **112**, a web browser interface **114**, a customer sign-up application **116**, customer personal settings **138**, a customer reports application **118**, a power savings application **120**, an ALC diagnostic manager **122**, an ALD database **124**, a service dispatch manager **126**, a trouble ticket generator **128**, a call center manager **130**, a carbon savings application **132**, a utility power and carbon database **134**, a read meter application **136**, and a security device manager **140**.

In one embodiment, customers interact with the ALD **100** using the web browser interface **114**, and subscribe to some or all of the services offered by the power load management system **10** via a customer sign-up application **116**. In accordance with the customer sign-up application **116**, the cus-

tomers specifies customer personal settings **138** that contain information relating to the customer and the customer’s residence or business, and defines the extent of service to which the customer wishes to subscribe. Customers may also use the web browser interface **114** to access and modify information pertaining to their existing accounts.

The ALD **100** also includes a UCC security interface **102** which provides security and encryption between the ALD **100** and a utility company’s control center **200** to ensure that no third party is able to provide unauthorized directions to the ALD **100**. A UCC command processor **104** receives and sends messages between the ALD **100** and the utility control center **200**. Similarly, an ALC security interface **110** provides security and encryption between the ALD **100** and each ALC **300** on the system **10**, ensuring that no third parties can send directions to, or receive information from, the ALC **300**. The security techniques employed by the ALC security interface **110** and the UCC security interface **102** may include conventional symmetric key or asymmetric key algorithms, or proprietary encryption techniques.

The master event manager **106** maintains the overall status of the power load activities controlled by the power management system **10**. The master event manager **106** maintains a separate state for each utility that is controlled and tracks the current power usage within each utility. The master event manager **106** also tracks the management condition of each utility (e.g., whether or not each utility is currently being managed). The master event manager **106** receives instructions in the form of transaction requests from the UCC command processor **104** and routes instructions to components necessary to complete the requested transaction, such as the ALC manager **108** and the power savings application **120**.

The ALC manager **108** routes instructions between the ALD **100** and each ALC **300** within the system **10** through an ALC interface **112**. For instance, the ALC manager **108** tracks the state of every ALC **300** serviced by specified utilities by communicating with the ALC **300** through an individual IP address. The ALC interface **112** translates instructions (e.g., transactions) received from the ALC manager **108** into the proper message structure understood by the targeted ALC **300** and then sends the message to the ALC **300**. Likewise, when the ALC interface **112** receives messages from an ALC **300**, it translates the message into a form understood by the ALC manager **108** and routes the translated message to the ALC manager **108**.

The ALC manager **108** receives from each ALC **300** that it services, either periodically or responsive to polling messages sent by the ALC manager **108**, messages containing the present power consumption and the status (e.g., “ON” or “OFF”) of each device controlled by the ALC **300**. Alternatively, if individual device metering is not available, then the total power consumption and load management status for the entire ALC **300** may be reported. The information contained in each status message is stored in the ALD database **124** in a record associated with the specified ALC **300**. The ALD database **124** contains all the information necessary to manage every customer account and power distribution. In one embodiment, the ALD database **124** contains customer contact information and associated utility companies for all customers having ALCs **300** installed at their residences or businesses, as well as a description of specific operating instructions for each managed device (e.g., IP-addressable smart breaker or appliance), device status, and device diagnostic history.

Another message that can be exchanged between an ALC **300** and the ALC manager **108** is a status response message.

A status response message reports the type and status of each device controlled by the ALC 300 to the ALD 100. When a status response message is received from an ALC 300, the ALC manager 108 logs the information contained in the message in the ALD database 124.

In one embodiment, upon receiving instructions (e.g., a “Cut” instruction) from the master event manager 106 to reduce power consumption for a specified utility, the ALC manager 108 determines which ALCs 300 and/or individually controlled devices to switch to the “OFF” state based upon present power consumption data stored in the ALD database 124. The ALC manager 108 then sends a message to each selected ALC 300 containing instructions to turn off all or some of the devices under the ALC’s control.

A read meter application 136 may be optionally invoked when the UCC command processor 104 receives a “Read Meters” or equivalent command from the utility control center 200. The read meter application 136 cycles through the ALD database 124 and sends a read meter message or command to each ALC 300, or to ALCs 300 specifically identified in the UCC’s command, via the ALC manager 108. The information received by the ALC manager 108 from the ALC 300 is logged in the ALD database 124 for each customer. When all the ALC meter information has been received, the information is sent to the requesting utility control center 200 using a business to business (e.g., ebXML) or other desired protocol.

Active Load Client

FIG. 3 illustrates a block diagram of an exemplary active load client 300 in accordance with one embodiment of the present invention. The depicted active load client 300 includes a smart breaker module controller 306, a communications interface 308, a security interface 310, an IP-based communication converter 312, a device control manager 314, a smart breaker (B1-BN) counter manager 316, an IP router 320, a smart meter interface 322, a smart device interface 324, an IP device interface 330, and a power dispatch device interface 340. The active load client 300, in this embodiment, is a computer or processor-based system located on-site at a customer’s residence or business. The primary function of the active load client 300 is to manage the power load levels of controllable, power consuming load devices located at the residence or business, which the active load client 300 oversees on behalf of the customer. In an exemplary embodiment, the active load client 300 may include dynamic host configuration protocol (DHCP) client functionality to enable the active load client 300 to dynamically request IP addresses for itself and/or one or more controllable devices 402-412, 60 managed thereby from a DHCP server on the host IP network facilitating communications between the active load client 300 and the ALD 100. The active load client 300 may further include router functionality and maintain a routing table of assigned IP addresses in a memory of the active load client 300 to facilitate delivery of messages from the active load client 300 to the controllable devices 402-412, 60. Finally, the power generation device 96 at the service point 20 sends data about power generated to the power dispatch device interface 340.

A communications interface 308 facilitates connectivity between the active load client 300 and the ALD server 100. Communication between the active load client 300 and the ALD server 100 may be based on any type of IP or other connection protocol including, but not limited to, the WiMax protocol. Thus, the communications interface 308 may be a wired or wireless modem, a wireless access point, or other appropriate interface.

A standard IP Layer-3 router 320 routes messages received by the communications interface 308 to both the active load client 300 and to any other locally connected device 440. The router 320 determines if a received message is directed to the active load client 300 and, if so, passes the message to a security interface 310 to be decrypted. The security interface 310 provides protection for the contents of the messages exchanged between the ALD server 100 and the active load client 300. The message content is encrypted and decrypted by the security interface 310 using, for example, a symmetric encryption key composed of a combination of the IP address and GPS data for the active load client 300 or any other combination of known information. If the message is not directed to the active load client 300, then it is passed to the IP device interface 330 for delivery to one or more locally connected devices 440. For example, the IP router 320 may be programmed to route power load management system messages as well as conventional Internet messages. In such a case, the active load client 300 may function as a gateway for Internet service supplied to the residence or business instead of using separate Internet gateways or routers.

An IP based communication converter 312 opens incoming messages from the ALD server 100 and directs them to the appropriate function within the active load client 300. The converter 312 also receives messages from various active load client 300 functions (e.g., a device control manager 314, a status response generator 304, and a report trigger application 318), packages the messages in the form expected by the ALD server 100, and then passes them on to the security interface 310 for encryption.

The device control manager 314 processes power management commands for various controllable devices logically connected to the active load client 300. The devices can be either smart breakers 402-412 or other IP based devices 60, 460, such as smart appliances with individual control modules (not shown). The device control manager 314 also processes “Query Request” or equivalent commands or messages from the ALD server 100 by querying a status response generator 304 which maintains the type and status of each device controlled by the active load client 300, and providing the status of each device to the ALD server 100.

The status response generator 304 receives status messages from the ALD server 100 and, responsive thereto, polls each controllable device 402-412, 60, 460 under the active load client’s control to determine whether the controllable device 402-412, 60, 460 is active and in good operational order. Each controllable device 402-412, 60, 460 responds to the polls with operational information (e.g., activity status and/or error reports) in a status response message. The active load client 300 stores the status responses in a memory associated with the status response generator 304 for reference in connection with power reduction events.

The smart device interface 324 facilitates IP or other address-based communications to individual devices 60 (e.g., smart appliance power control modules) that are attached to the active load client 300. The connectivity can be through one of several different types of networks including, but not limited to, BPL, ZigBee, Wi-Fi, Bluetooth, or direct Ethernet communications. Thus, the smart device interface 324 is a modem adapted for use in or on the network connecting the smart devices 60 to the active load client 300.

The smart breaker module controller 306 formats, sends, and receives messages to and from the smart breaker module 400. In one embodiment, the communications is preferably

through a BPL connection. In such embodiment, the smart breaker module controller **306** includes a BPL modem and operations software. The smart breaker module **400** contains individual smart breakers **402-412**, wherein each smart breaker **402-412** includes an applicable modem (e.g., a BPL modem when BPL is the networking technology employed) and is preferably in-line with power supplied to a single appliance or other device. The B1-BN counter manager **316** determines and stores real time power usage for each installed smart breaker **402-412**. For example, the counter manager **316** tracks or counts the amount of power used by each smart breaker **402-412** and stores the counted amounts of power in a memory of the active load client **300** associated with the counter manager **316**.

The smart meter interface **322** manages either smart meters **460** that communicate using BPL or a current sensor **452** connected to a traditional power meter **450**. When the active load client **300** receives a "Read Meters" command or message from the ALD server **100** and a smart meter **460** is attached to the active load client **300**, a "Read Meters" command is sent to the meter **460** via the smart meter interface **322** (e.g., a BPL modem). The smart meter interface **322** receives a reply to the "Read Meters" message from the smart meter **460**, formats this information along with identification information for the active load client **300**, and provides the formatted message to the IP based communication converter **312** for transmission to the ALD server **100**.

Customer Profiles

The embodiments disclosed make use of the "customer profiles" concept. The ALMS enables data to be gathered to generate a profile of each customer, including information about controllable energy consuming devices, and the related individual structures or service points. Customer profiles reside within the Active Load Director Database **124** in the Active Load Director **100**. Included in this customer profile is the customer's pattern of energy consumption. The customer profile includes, but is not limited to, the following: (1) customer name; (2) customer address; (3) geodetic location; (4) meter ID; (5) customer programs (possibly including program history); (6) device information, including device type and manufacturer/brand; (7) customer energy consumption patterns; and (8) connection and disconnection profile. The connection/disconnection profile can include service priority (i.e., elderly, police, etc.) and disconnection instructions.

The customer profile is created by using data gathered from within the ALMS. Data gathered or calculated includes, but is not be limited to, the following: (1) set points; (2) energy and average energy used in a given time period; (3) energy and average energy saved in a given time period; (4) drift time per unit temperature and average drift time; and (5) power time per unit temperature and average power time per unit temperature.

In other embodiments, additional data called "variability factors" may be captured by the ALMS as part of the customer profile, including, but not limited to, the following: (1) outside temperature, (2) sunlight, (3) humidity, (4) wind speed and direction, (5) elevation above sea level, (6) orientation of the service point structure, (7) duty duration and percentage, (8) set point difference, (9) current and historic room temperature, (10) size of structure, (11) number of floors, (12) type of construction (brick, wood, siding etc.) (13) color of structure, (14) type of roofing material and color, (15) construction surface of structure (built on turf, clay, cement, asphalt etc.), (16) land use (urban, suburban, rural), (17) latitude/longitude, (18) relative position to jet

stream, (19) quality of power to devices, (20) number of people living in and/or using structure and (21) other environmental factors.

Additional factors may also be deemed necessary for determining unique energy consumption patterns and generating performance curves and data matrices for usage in load control events and other purposes detailed in this and related patent applications.

By way of example, based upon the reduction in consumed power, the systems and methods of the present invention provide for generating at the control center a power supply value (PSV) corresponding to the reduction in consumed power by the power consuming device(s). Importantly, the PSV is an actual value that includes measurement and verification of the reduction in consumed power; such measurement and verification methods may be determined by the appropriate governing body or authority for the electric power grid(s). Power Supply Value (PSV) is calculated at the meter or submeter or at building control system or at any device or controller that measures power within the standard as supplied by the regulatory body(ies) that govern the regulation of the grid. PSV variations may depend on operating tolerances, operating standard for accuracy of the measurement. The PSV enables transformation of curtailment or reduction in power at the device level by any system that sends or receives an IP message to be related to or equated to supply as presented to the governing entity that accepts these values and award supply equivalence, for example of a power generating entity or an entity allowed to control power consuming devices as permitted by the governing body of the electric power grid, e.g., FERC, NERC, etc.

PSV may be provided in units of electrical power flow, monetary equivalent, and combinations thereof. Thus, the PSV provides an actual value that is confirmed by measurement and/or verification, thereby providing for a curtailment value as a requirement for providing supply to the power grid, wherein the supply to the power electric power grid is provided for grid stability, voltage stability, reliability, and combinations thereof, and is further provided as responsive to an energy management system or equivalent for providing grid stability, reliability, frequency as determined by governing authority for the electric power grid and/or grid operator(s).

As part of the Active Load Directory (ALD), the methods described herein consolidate this information creating a historic energy consumption pattern reflecting the amount of energy used by each service point to maintain its normal mode of operation. This energy consumption pattern is part of a customer's profile.

Energy consumption patterns are subject to analysis that may be used for a variety of different types of activities. For example, based on the energy consumption patterns created from this data, the ALD will derive performance curves and/or data matrices for each service point to which the Active Load Management System is attached and determine the amount of energy reduction that can be realized from each service point. The ALD will create a list of service points through which energy consumption can be reduced via demand side management, interruptible load, or spinning/regulation reserves. This information can be manipulated by the ALD processes to create a prioritized, rotational order of control, called "intelligent load rotation" which is described in detail below. This rotational shifting of the burden of the interruptible load has the practical effect of reducing and flattening the utility load curve while allowing

the serving utility to effectively group its customers within the ALD or its own databases by energy efficiency.

The practical application of this data is that in load control events, a utility can determine the most efficient service points to dispatch energy from, or more importantly derive the most inefficient service points (e.g., homes, small businesses, communities, structures, or devices) within the utility's operating territory. Based on this information, highly targeted conservation programs could have an immediate impact to improve energy efficiency. From a marketing perspective, this is invaluable information because it contains the comfort preference of a service point compared against the capabilities of the service point's energy consuming devices, or the lack of efficiency of those devices. From a national security point of view, the profiles could be used to determine habits of monitored end customers in a similar fashion to how Communications Assistance for Law Enforcement Act (CALEA) is used by law enforcement for wire-tapping. Utilities may use energy consumption patterns to categorize or group customers for service, control event, marketing, sales, or other purposes. Other uses of energy consumption patterns are possible that determine or predict customer behavior.

Generally, the embodiments described encompass a closed loop system and method for creating a customer profile, calculating and deriving patterns of energy drift, and making use of those patterns when implemented through the machinery of a system comprised of load measurement devices combined with the physical communications link and when these inputs are manipulated through a computer, processor, memory, routers and other necessary machines as those who are skilled in the art would expect to be utilized.

Drift

The embodiments described also make use of the concept of "drift." The data gathered for the customer profile is used to empirically derive the decay rate or drift, temperature slope, or a dynamic equation ($f\{x\}$) whereby the service point (or device) will have a uniquely derived "fingerprint" or energy usage pattern.

Drift occurs when a climate-controlled device begins to deviate from a set point. This may occur both normally and during control events. Customers define the upper and lower boundaries of comfort in customer preferences, with the set point in the middle of those boundaries. During normal operation, a climate controlled device will attempt to stay near the device's set point. However, all devices have a duty cycle that specifies when the device is in operation because many devices are not continuously in operation. For a climate-controlled device, the duty cycle ends when the inside temperature reaches, or is within a given tolerance of, the set point. This allows the device to "drift" (upward or downward) toward a comfort boundary temperature. Once the boundary temperature is reached, the duty cycle begins again until the inside temperature reaches, or is within a given tolerance of, the set point which ends the duty cycle.

Therefore, drift is the time it takes for a climate-controlled device to move from the set point to the upper or lower comfort boundary. Drift is calculated and recorded for each service point and for each device associated with the service point. The inverse of drift is "power time" which is the time it takes for the device to move from the comfort boundary to the set point.

Drift may also occur during a control event. A control event is an action that reduces or terminates power consumption of a device. During a control event, a climate-controlled device will drift toward maximum or minimum control event boundaries (upper or lower) until it reaches

that boundary which is normally outside the comfort boundary. Once it reaches the control event boundary, the ALMS returns power to the device to enable it to reach the set point again.

As an example, an HVAC system may have a set point of 72 degrees and a minimum and maximum temperature of 68 degrees and 76 degrees, respectively. On a cold day, a control event would cause the HVAC system to begin to lose power and move toward the minimum temperature. Once the structure reaches the minimum temperature, the control event would end, and power would be restored to the HVAC system, thus causing the temperature to rise toward the preferred temperature. A similar but opposite effect would take place on a warm day.

In some embodiments, drift, as well as other measurements available from the active load director data base **124**, are used to create an energy consumption pattern for each service point. Additional measurements may include vacancy times, sleep times, times in which control events are permitted, as well as variability factors referred to previously.

A device that resides within an energy-efficient structure will have a tendency to cool or heat more slowly, thus exhibiting a lower rate of drift. These devices may be subject to control events for longer periods of time, commensurate with the rate of drift, because it takes them longer to drift to a comfort boundary.

In another embodiment, the active load director server **100** identifies service points that have an optimum drift for power savings. The power savings application **120** calculates drift for each service point and saves that information in the active load director data base **124**.

Intelligent Load Rotation

The embodiments disclosed also make use of the "intelligent load rotation" concept. Intelligent load rotation uses machine intelligence to ensure that the same service points are not always selected for control events, but distributes control events over a service area in some equitable way.

There are a variety of ways in which intelligent load rotation may be implemented. In one embodiment of intelligent load rotation, service points are simply selected in a sequential list until the end is reached, after which selection starts at the top of the list again. This is a fairly straightforward approach that may be implemented by any one skilled in the art.

FIG. 6 illustrates an operational flow diagram of the basic intelligent load rotation algorithm **1800**. All other embodiments of intelligent load rotation are based on this embodiment. In general, the algorithm goes through each service point within a group of service points, and sends control events to each of those service points until enough energy savings have been obtained.

In its most basic form, the algorithm first identifies a group selection criteria as indicated in logic block **1802**. This may be as simple as all service points or may be more complex, such as selecting service points within a specified drift or within a specified geographic area. The group selection criteria may include, but is not limited to, any of the following: (1) random selection of service points; (2) drift; (3) grouping of logical geodetic points by a utility; (4) efficiency rating of appliances; (5) ALD customer preferences; (6) capacity of devices; (7) proximity to transmission lines; (8) pricing signals (both dynamic and static); and (9) service priority, based upon an emergency situation (i.e. fire, police, hospital, elderly, etc.).

The algorithm then identifies an individual service point selection criterion as indicated in logic block **1804**. This is

the criterion for selecting individual service points within a group. In its simplest embodiment, this criterion involves sequential selection of service points within the group. Other criteria may include random selection, selection based on number of previous control events, or other criteria.

Next, the algorithm creates a candidate list of service points based on the group selection criteria as indicated in logic block **1806**. From this list, the algorithm selects a service point based on the individual service point selection criteria as indicated in logic block **1810**. The ALMS then sends a control event to the selected service point as indicated in logic block **1814**, and calculates the energy savings of that control event based on drift calculation as indicated in block **1816**. The algorithm then determines if more energy savings are needed to reach the savings target as indicated in decision block **1820**. If not, then the ALMS records where the algorithm ended in the candidate list as indicated in block **1824** and exits. If more energy savings are needed, then the ALMS determines if any more service points are in the candidate list as indicated in decision block **1830**. If there are no more service points in the candidate list, then the algorithm returns to the beginning of the candidate list again in logic block **1840**. Otherwise, if there are more service points in the candidate list, the algorithm simply returns to logic block **1810**.

In an alternate embodiment, decision block **1820** may be modified to determine if more service points are to be selected from this group.

There are many other embodiments of intelligent load rotation. Many embodiments are based on the group selection criteria. Service points may be grouped by geography or some other common characteristic of service points. For example, groups might include “light consumers” (because they consume little energy), “daytime consumers” (because they work at night), “swimmers” (for those who have a pool and use it), or other categories. These categories are useful to the utility for quickly referring to customers with specific energy demographics. The utility may then select a number of service points in each group for control events to spread control events among various groups.

In another embodiment, optimum drift can be used as the group selection criteria. Because those service points will use the least energy, the utility may want to select those service points that are the most energy efficient.

In another embodiment, a group of service points is selected that have had the fewest control events in the past. This ensures that service points with the most control events in the past will be bypassed in favor of those who have received fewer control events.

In another embodiment, with reference to FIGS. **4-5**, drift is used as a means of intelligent load rotation. As data is collected by the ALMS, it is possible to calculate the total drift of a device over time, as shown in FIG. **4**. The calculation for one service point represents one vector on the graph. Each vector represents the drift for a single service point. To identify the service points with the optimal drift, the ALD **100** determines the median drift and all service points having a drift that is within one standard deviation away from that median. That represents the shaded area in the graph depicted in FIG. **5**. If sufficient service points cannot be found that are within one standard deviation, then the second standard deviation can be selected.

In another embodiment, energy consumption patterns in customer profiles are used to identify service points that are the best targets for excess power sharing. This would occur when renewable energy such as solar or wind is added to the grid, resulting in power that cannot be compensated for by

the grid. This could occur, for example, on very windy days. When this happens, utilities are faced with the problem of what to do with the excess energy. Instead of cutting power to service points in order to affect power savings, a utility could add energy to service points in order to effect power dissipation. The service points selected by the utility may be different (or even the inverse) of those selected for power savings. The devices at these service points would be turned on if they were off or set points for climate-controlled devices would be adjusted to heat or cool more than normal. Spread out over many control points, this can provide the energy dissipation needed.

In a further embodiment, energy consumption patterns within customer profiles could be used to identify opportunities for up selling, down selling, or cross selling. These opportunities may be determined by the power utility or by its partners. Data from customer profiles may be used to provide insights on inefficient devices, defective devices, or devices that require updating to meet current standards. Customer profile data may also be used to identify related sales opportunities. For example, if energy consumption patterns suggest that the customer may be very interested in personal energy conservation, then sales efforts could be directed toward that individual concerning products related to that lifestyle. This information can be used by the utility or its partners to provide incentives to customers to buy newer, updated devices, or obtain maintenance for existing devices. The customer is given the option to opt out of having his customer profile used for sales and marketing efforts, or for regulating energy conservation. The customer profile makes use of open standards (such as the CPEX-change standard) that specify a privacy model with the customer profile. The use of consumption patterns in this manner is governed by national, state, or local privacy laws and regulations.

A further embodiment of using customer profiles to identify sales opportunities involves the use of device information to create incentives for customers to replace inefficient devices. By identifying the known characteristics and/or behavior of devices within a service point, the invention identifies those customers who may benefit from replacement of those devices. The invention estimates a payback period for replacement. This information is used by the ALMS operator to create redemptions, discounts, and campaigns to persuade customers to replace their devices.

It should be noted that many terms and acronyms are used in this description that are well-defined in the telecommunications and computer networking industries and are well understood by persons skilled in these arts. Complete descriptions of these terms and acronyms, whether defining a telecommunications standard or protocol, can be found in readily available telecommunications standards and literature and are not described in any detail herein.

As used in the foregoing description, the term “ZigBee” refers to any wireless communication protocol adopted by the Institute of Electrical and Electronics Engineers (IEEE) according to standard 802.15.4 or any successor standard(s), and the term “Bluetooth” refers to any short-range communication protocol implementing IEEE standard 802.15.1 or any successor standard(s). The term “High Speed Packet Data Access (HSPA)” refers to any communication protocol adopted by the International Telecommunication Union (ITU) or another mobile telecommunications standards body referring to the evolution of the Global System for Mobile Communications (GSM) standard beyond its third generation Universal Mobile Telecommunications System (UMTS) protocols. The term “Long Term Evolution (LTE)”

refers to any communication protocol adopted by the ITU or another mobile telecommunications standards body referring to the evolution of GSM-based networks to voice, video and data standards anticipated to be replacement protocols for HSPA. The term “Code Division Multiple Access (CDMA) Evolution Data-Optimized (EVDO) Revision A (CDMA EVDO Rev. A)” refers to the communication protocol adopted by the ITU under standard number TIA-856 Rev. A.

It will be appreciated that embodiments or components of the systems described herein may be comprised of one or more conventional processors and unique stored program instructions that control the one or more processors to implement, in conjunction with certain non-processor circuits, some, most, or all of the functions for managing power load distribution, and tracking and controlling individual subscriber power consumption and savings in one or more power load management systems. The non-processor circuits may include, but are not limited to, radio receivers, radio transmitters, antennas, modems, signal drivers, clock circuits, power source circuits, relays, meters, smart breakers, current sensors, and customer input devices. As such, these functions may be interpreted as steps of a method to distribute information and control signals between devices in a power load management system. Alternatively, some or all functions could be implemented by a state machine that has no stored program instructions, or in one or more application specific integrated circuits (ASICs), in which each function or some combinations of functions are implemented as custom logic. Of course, a combination of the two approaches could be used. Thus, methods and means for these functions have been described herein. Further, it is expected that one of ordinary skill in the art, notwithstanding possibly significant effort and many design choices motivated by, for example, available time, current technology, and economic considerations, when guided by the concepts and principles disclosed herein, will be readily capable of generating such software instructions, programs and integrated circuits (ICs), and appropriately arranging and functionally integrating such non-processor circuits, without undue experimentation.

In the foregoing specification, the invention has been described with reference to specific embodiments. However, one of ordinary skill in the art will appreciate that various modifications and changes may be made without departing from the scope of the present invention as set forth in the appended claims. Accordingly, the specification and drawings are to be regarded in an illustrative rather than a restrictive sense, and all such modifications are intended to be included within the scope of the present invention.

The corresponding structures, materials, acts, and equivalents of all means plus function elements in any claims below are intended to include any structure, material, or acts for performing the function in combination with other claim elements as specifically claimed.

In addition, it is possible to use some of the features of the embodiments disclosed without the corresponding use of the other features. Accordingly, the foregoing description of the exemplary embodiments is provided for the purpose of illustrating the principles of the invention, and not in limitation thereof, since the scope of the present invention is defined solely by the appended claims.

What is claimed is:

1. A method for determining and using customer energy profiles to manage electrical load control events on a communications network between a server in communication with an electric grid operator or any market participant

associated with an electric power grid and a plurality of customers at a plurality of service points, comprising:

generating, a plurality of customer profiles for the plurality of customers, wherein each customer profile comprises at least energy consumption information for a plurality of controllable energy consuming devices at the plurality of service points, wherein the plurality of controllable energy consuming devices include a plurality of controllable temperature control devices or building control systems;

storing the plurality of customer profiles in a database for use in load control events;

aggregating the plurality of customer profiles into at least one aggregate customer profile based on at least one predetermined criterion;

generating a candidate list of service points for load control events based on the at least one predetermined criterion;

sending a load control event to at least one service point selected from the candidate list of service points in response to an energy reduction request including a target energy savings received from the electric grid operator or any market participant associated with the electric power grid via the communications network;

determining an energy savings for the plurality of controllable energy consuming devices resulting from a reduction in consumed power associated with the load control event at the at least one service point, wherein the energy savings is determined based on a monetary supply equivalent value for each of the plurality of controllable energy consuming devices, wherein each monetary supply equivalent value is a measurement and a verification of the reduction in consumed power by each of the plurality of controllable energy consuming devices, wherein the monetary supply equivalent value is a curtailment value as a supply accepted by governing entities for awarding the plurality of customers; and

determining the resulting energy savings is at least equal to the target energy savings.

2. The method of claim 1, further comprising transforming the measurement and the verification of the reduction in consumed power into a power supply value (PSV) corresponding to each of the plurality of controllable energy consuming devices and aggregating the PSV corresponding to each of the plurality of controllable energy consuming devices into at least one aggregate PSV.

3. The method of claim 2, further comprising associating the at least one aggregate PSV with the at least one aggregate customer profile.

4. The method of claim 1, wherein the energy consumption information includes at least one of a set point for a climate-controlled device, an energy use in a specified time period, an energy savings in a specified time period, a drift time per unit temperature, and a power time per unit temperature.

5. The method of claim 1, wherein each customer profile further includes a plurality of variability factors resulting in a unique energy consumption pattern at an associated service point.

6. The method of claim 1, further comprising determining a drift associated with each service point, wherein the drift is an amount of time for a climate-controlled device to move from a set point temperature to an upper or lower temperature boundary defined in a customer profile.

7. The method of claim 6, further comprising determining a power time associated with each service point, wherein the

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power time is an amount of time for the climate-controlled device to move from the upper or the lower temperature boundary defined in the customer profile to the set point temperature.

8. The method of claim 6, wherein the set point temperature is a temperature that is a midpoint between the upper and the lower temperature boundary defined in the customer profile.

9. The method of claim 1, wherein a temperature associated with a climate-controlled device at the at least one service point drifts towards a maximum or a minimum temperature boundary during the load control event.

10. The method of claim 9, further comprising returning power to the climate-controlled device when either the maximum or the minimum temperature boundary is reached.

11. The method of claim 1, further comprising generating an energy consumption pattern for each service point.

12. The method of claim 11, further comprising deriving a performance curve for each service point, and determining an amount of energy reduction that can be realized from the load control event at each service point.

13. The method of claim 1, further comprising sending the load control event to at least one selected additional service point in the candidate list of service points in order to reach the target energy savings.

14. The method of claim 1, further comprising determining an individual service point selection criterion for selecting individual service points.

15. The method of claim 1, wherein the at least one predetermined criterion for aggregating the plurality of customer profiles includes any one of a random selection, a drift factor, a logical geodetic point, an efficiency rating for each controllable temperature control device at an associated service point, a customer preference, a proximity to a transmission line, a pricing signal, and a priority for an emergency situation.

16. The method of claim 1, wherein each customer profile further includes identification of any power generating device at an associated service point that can be added to the electric power grid in response to the load control event sent to the at least one service point.

17. The method of claim 1, wherein each customer profile further includes at least one of a customer name, a customer address, a meter identifier, and controllable temperature device information for each of the plurality of energy consuming devices.

18. The method of claim 1, further comprising applying the load control event to at least one of the plurality of controllable energy consuming devices at the at least one service point.

19. A system for determining and using customer energy profiles to manage electrical load control events on a communications network between a server in communication with an electric grid operator or any market participant associated with an electric power grid and a plurality of customers at a plurality of service points, comprising:

a memory storing a database containing a plurality of customer profiles for load control events wherein each customer profile includes at least energy consumption information for a plurality of controllable temperature control devices at the plurality of service points;

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a server processor, cooperative with the memory, and configured for managing the load control events on the communications network to the plurality of service points by:

generating a plurality of customer profiles for the plurality of customers;

aggregating the plurality of customer profiles into at least one aggregate customer profile based on at least one predetermined criterion;

generating a candidate list of service points for load control events based on the at least one predetermined criterion;

sending a load control event to at least one service point selected from the candidate list of service points in response to an energy reduction request including a target energy savings received from the electric grid operator or any market participant associated with the electric power grid via the communications network;

determining an energy savings for the plurality of controllable temperature control devices resulting from the load control event at the at least one service point, wherein the energy savings is determined based on a monetary supply equivalent value for each of the plurality of controllable temperature control devices, wherein each monetary supply equivalent value is a measurement and a verification of the reduction in consumed power corresponding to each of the plurality of controllable temperature control devices, wherein the monetary supply equivalent value is a curtailment value as a supply accepted by governing entities for awarding the plurality of customers;

determining the resulting energy savings is at least equal to the target energy savings.

20. The system of claim 19, wherein a load to be controlled by the load control event includes a native load and/or operating reserves including regulating, spinning, and non-spinning types.

21. The system of claim 19, wherein the reduction in consumed power is transformed into a power supply value corresponding to each of the plurality of controllable temperature control devices.

22. The system of claim 21, wherein the power supply value for each of the plurality of controllable temperature control devices is transformed into an aggregate power supply value that is compared to the target energy savings for the load control event.

23. The system of claim 22, wherein the processor is further configured for associating the aggregate power supply value with the at least one aggregate customer profile.

24. The system of claim 19, wherein the processor is further configured for selecting the at least one service point based on an individual service point criterion.

25. The system of claim 19 wherein the at least one predetermined criterion for aggregating the plurality of customer profiles includes any one of a random selection, a drift factor, a logical geodetic point, an efficiency rating for each controllable temperature control device at an associated service point, a customer preference, a proximity to a transmission line, a pricing signal, and a priority for an emergency situation.

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